N.A.C.A. BULLETIN

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FEBRUARY 1, 1949

MOST PROFITABLE PRODUCT VOLUME—TAKING ACCOUNT OF COSTS AND COMPETITION

by LEONARD J. DOYLE,

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Three situations in which related price and cost behavior may be expected to show characteristics identifiable with competitive conditions under which a company operates are described and graphically illustrated in this presentation. In none of these three instances, as developed, does optimum volume necessarily coincide with that of minimum average unit cost or practical capacity. The article seriously questions the utility of conventional overhead allocations to products.

THE man or company that knows the limitations set by its size and environment may live happily within its resources and abilities. A business is like a person. It may seek to be in perfect condition but seldom completely achieves its goal. Like the average person, it strives for reasonable health and, like most persons, it is primarily interested in surviving as long as possible. Each business, like each individual, has limits set by its body type and its physical environment. It is important to understand these limitations.

One of the ways in which economics can help management and cost accounting is in throwing light on the various "body types" or classes of business life and the problems of living encountered by business firms in each class. To continue a medical analogy, economic theory can indicate to management what sort of data is required to enable it to judge its corporate health and can suggest measures for improvement.

Rational Behavior and the Individual Enterprise

Economic theory as applied to a particular firm is concerned with the analysis of rational behavior in a free enterprise economy. Rational behavior is defined as that which maximizes profit or minimizes loss over the period of time for which a policy decision is made. Since the goal is profit, we are interested in the relation between cost and revenue which maximizes profit.

In order to formulate a production and price policy, it is necessary to analyze the type of competition encountered by the firm.

In other words, what is the "body type" of the firm and what behavior can it expect to follow in its effort to stay alive and healthy? There is a multiplicity of types of competition. Management, including accounting management, must decide the extent to which it is: (1) dealing with the broad impersonal forces of the market, (2) dealing with one or more competitors, or (3) setting prices for the other firms to follow. Having so oriented itself, it must then decide how in the particular situation to determine what and how much to produce of particular product items.

The Question of Relevant Costs

This does not involve costs alone but, so far as it does and so far as it concerns costs by products, most industrial cost accountants and all cost accountants for wholesale and retail firms will find that multiproduct costing is their major problem. To this problem, a great many firms add the problem of multiplant operation. In a complex situation such as these circumstances may create, what costs are relevant for management and how should they be presented? I believe it can be agreed that fixed and common costs offer the greatest possibility of confusion due to conventional methods of handling them. Fixed costs are here used to indicate such costs as depreciation, property taxes, and property insurance. Common costs are used to indicate overhead costs such as guards, fire protection, personnel, accounting, general plant management, etc. Rightly or wrongly, it is common to allocate both types to production departments and then to products. In my opinion, the result of this is to obscure essential facts.

The early theoretical development of cost accounting centered around the analysis of overhead and its allocation to products. With the benefit of hindsight, I believe it is fair to say that the theories developed have had some regrettable effects on management and on cost accountants. The most unfortunate effect of allocating overhead to products is that it sanctifies the resulting unit cost figures. We tend to lose sight of the fact that full product costing is only a way of allocating total profit or loss to products. Too many cost accountants think that unit costs resulting from a system of allocation must be satisfactory for all purposes, for inventory, periodic profit and loss calculations, price quotations, price regulation, and others. However, for certain managerial decisions, some costs are relevant and others are not.

In determining the best product mix and the related price policy, let us see the theoretical problem and its solution. As a starting point, a firm has its existing plant and equipment. To this it can make a limited number of changes in the immediate future. The first problem is the extent of control which the firm has over its prices and product design, i. e., what is its competitive class?

Case No. 1: Unlimited Quantity at Price Set by Competition

Let us first assume that prices are set by competition and that the company can sell all it can produce of any product. Such a competitive situation would aproximate pure and perfect competition. Under such conditions, what product mix would maximize profit? It would be necessary to *exclude* from each product all fixed costs of the firm and all semifixed and variable costs associated with the general operation as distinguished from the production and sale of each product. The only relevant costs would be the variable costs of production and distribution. Since the firm can sell all it produces of each product at the market price, it must know the behavior of variable cost in relation to volume.

If variable cost per unit were constant at all possible levels of output, it follows that the firm would have no product mix at all because it would select the product with the highest difference between selling price and variable cost and produce only that product. The unit of measurement, however, would have to be in terms of plant capacity rather than actual units of the commodity.

What are the reasons why a firm could not expect constant variable cost per unit? The most important reason for most firms is the existence of specialized equipment and personnel. Each firm is a product of its own past and usually has the mixture of specialized equipment found advantageous in prior periods. Specialized equipment forces up unit variable cost as output is increased. Part of this increase in cost is from overtime and shift premiums and part from adding less experienced workers to the labor force. In many plants it is possible to increase the output of one product by using equipment intended primarily for other products as well as from using standby or retired equipment. Such added production is almost always obtained only at higher unit variable cost. If we show such cost behavior on a graph, it would look like Exhibit 1.

Unit variable cost declines as production increases from zero to OQ_1 and is virtually constant at volumes between OQ_1 and OQ_2. This is the range of output with which most firms are familiar.

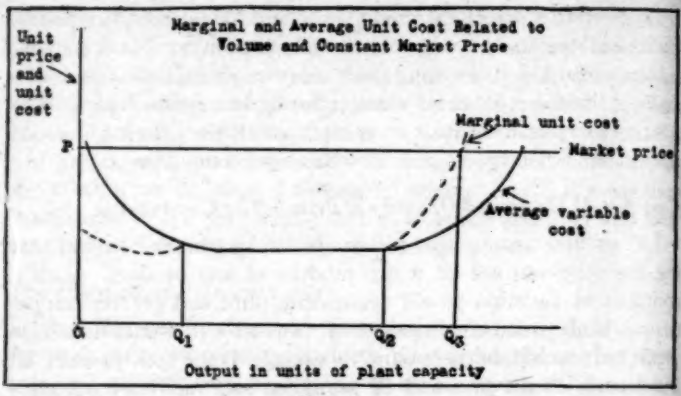

EXHIBIT 1

After OQ_2 the additional or marginal cost of production rises sharply and of course pulls up the average variable cost. If the price remained OP for any volume, then the quantity OQ_3 would maximize the dollar margin contributed by that product. It will be noted that the output in this case is not the one at which average variable cost is at a *minimum* but an output a little larger, or *where marginal cost equals price.*

If the quantity OQ_3 maximizes the margin contributed by one product, a similar analysis should be made of the costs of producing the other products. Each product should be produced in the volume which equates marginal cost and selling price. Such a procedure would give the product mix which would furnish the largest total dollar margin of revenue over variable product costs. This margin is available for fixed and other common costs not a function of product mix, including depreciation of the specialized equipment. Repair of equipment, however, should be considered a variable cost of each product.

Case No. 2: Restricted Quantity at Price Set by Competition

The foregoing analysis is of limited use in industrial cost practice because few firms normally have an assured market for all they can produce. Let us take a more frequently encountered situation. This is one in which the firm still does not set the price and furthermore can sell only a limited amount at the market. In such a situation selling costs become important. On Exhibit 1 the variable costs are those of manufacture. If we take the data from

Exhibit 1 and add selling cost, we might secure a situation such as is shown on Exhibit 2.

The volume scale is the same for each chart. On Exhibit 2, the volume OQ_4 (which happens to be the same as OQ_3 on Exhibit 1) would produce average variable costs for manufacturing and selling combined which equal the selling price. This volume would produce no margin for the product at all. However, any volume between OQ_1 and OQ_4 would produce *some* margin. OQ_2 would provide the largest margin per unit and OQ_3 the largest dollar margin. This is—or should be—the volume management is after. The important point here is that the maximum dollar margin is obtained at a volume where unit variable manufacturing costs are constant or trending upward slightly.

It is quite possible that a firm may find that for one product its selling costs start to increase at a volume at which manufacturing costs are still constant or declining, whereas for another product manufacturing costs start to go up while selling costs are constant or falling. It is the sum of the two which management needs, and particularly the behavior of marginal cost after the minimum combined average variable cost is reached. If marginal cost then rises sharply, the profit maximizing volume will be just a little larger than the volume at which average variable cost is lowest. The most profitable product mix, as in the first case, is simply the sum of the most profitable volumes for each product—and, to repeat, this is determined solely on the basis of variable product costs.

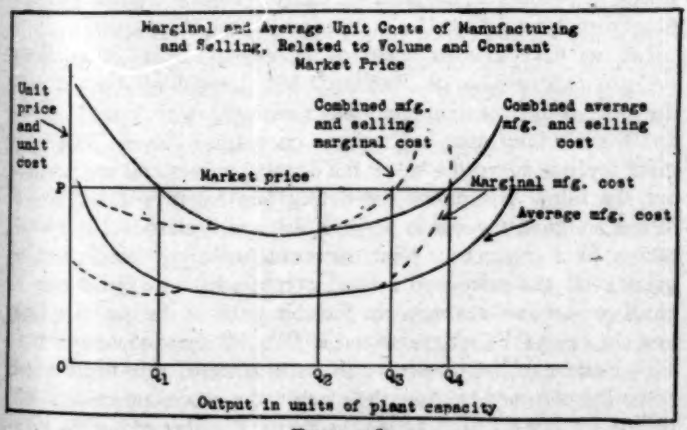

Exhibit 2

Case No. 3: Price Dependent on Own Output

To round out our picture, let us look at the case of a firm that sets prices, either for the industry or for itself. The *principle* of equating marginal product cost with selling price can also be stated as equating marginal cost with marginal revenue. If a firm can sell at a fixed price, then each additional unit sold adds the sales price to total revenue. In such a case marginal revenue and selling price are identical. For a firm that must establish prices, however, the outstanding fact is that the price influences the quantity which can be sold. We all know that for most products and services the quantity which can be sold varies inversely with price. We also know that in reducing unit price one may also reduce total dollar sales even though the quantity sold increases. When this happens we say the demand is inelastic.

If a firm takes only a short-run view, it will always set a price in the price range in which demand is elastic, i.e., where a price increase will reduce total dollar sales and a price reduction will increase total dollar sales. This follows from the fact that total profit can be increased by expanding volume only if the expansion adds more to revenue than to cost. One can only add to revenue by expanding output if demand is elastic. Conversely, one can increase profit by *reducing* output only if the reduction in revenue is exceeded by the reduction in cost. But if demand is *inelastic* an increase in price, while still reducing the *quantity* sold, actually increases total dollar sales. This offers the possibility, therefore, in pricing a product in the inelastic range, of using a price increase to increase total dollar sales and decrease total dollar costs.

Let us have another look at the charts. Exhibit 3 shows the cost information on Exhibit 2 but, instead of a fixed selling price (and constant marginal revenue), two demand curves and the resulting marginal revenue curves are shown. The marginal revenue curves lie below the demand curves and are positive for the initial portion of the output and negative for the rest. When marginal revenue is positive, demand is elastic. The contribution of a product to joint overhead, including fixed costs, is greatest at the price and related output where marginal cost is equal to marginal revenue. In Exhibit 3 this is the quantity OQ_2 and the price OP_1 when demand is DD_1. If demand decreases to DD_2 because of a recession or the emergence of new firms which force the old ones to share the market, the maximum margin will be at a smaller output, OQ_1 on the chart. Whether or not the price

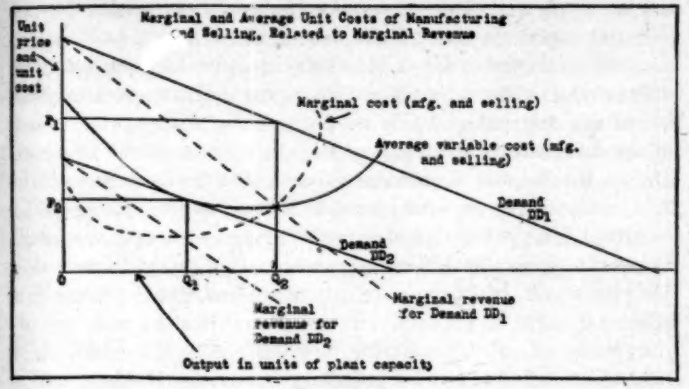
Marginal and Average Unit Costs of Manufacturing and Selling, Related to Marginal Revenue
Unit price and unit cost
Marginal cost (mfg. and selling)
Average variable cost (mfg. and selling)
Demand DD1
Demand DD2
Marginal revenue for Demand DD1
Marginal revenue for Demand DD2
Output in units of plant capacity

EXHIBIT 3

will necessarily be lower depends upon the nature of the shift in demand. In the limiting case indicated by DD_2 price would be lower—OP_2 instead of OP_1.

It will be only a coincidence if the best output of a firm is where average variable cost is a minimum and likewise a coincidence if the best output falls at either the level we call practical capacity or average capacity. The respective cases for practical capacity and average capacity depend principally on the virtues of one or the other in showing the cost of excess or idle capacity and in providing a basis for setting prices. All of these arguments are without real merit. What management wants is profit. There is no reason to believe that the percentage of plant capacity which produces the maximum profit this year will do it next year. At certain times, the worst thing possible is to try to operate a plant at practical capacity. The price reduction necessary to move the output may add less to sales than the volume adds to cost.

Misleading Results of Fixed Cost Allocations

Costs have too often been thought of in terms of inventory valuations. It may even be said that cost accountants have let the inventory tail wag the cost dog. In trying to avoid the effects on total unit cost of fixed costs under conditions of varying output, cost accountants have adopted bases for allocating overhead when they should have refused to allocate the overhead to products at all. It seems proper to me to indict management for this even more than cost accountants. Businessmen like to talk about the

law of supply and demand but they frequently neglect the demand side and expect the cost side to provide all the answers. The great English economist, Alfred Marshall, in discussing the operation of supply and demand in establishing prices, said that it is as foolish to say that *either* supply or demand determines price as it is to say that one blade of a pair of scissors cuts the cloth. The moral of this for the cost accountant is to be very much on the careful side in furnishing costs which are to be used in establishing prices.

Alfred Marshall also had something to say about prices which is equally applicable to costing problems of the individual firm. He pointed out that prices are interdependent and if one moves it affects, directly or indirectly, all others. Prices, he said, are like marbles in a bowl. If you move one you change the relative position of all the others. This is just as true of costs. If the cost of one factor of production changes, it will affect the *relative* position of all others. This is particularly true when several products are produced. If total costs are allocated to products, a change in the proportion of the products will affect the profits of all, even if the volume of only one product actually changes. This is illustrated by the following simple example in which overhead or common costs are allocated to products on the basis of variable or direct cost in two successive periods.

Period 1

	Total		*Product A*		*Product B*		*Product C*	
	Amount	*%*	*Amount*	*%*	*Amount*	*%*	*Amount*	*%*
Net sales	$100,000	100	$50,000	100	$30,000	100	$20,000	100
Variable costs	50,000	50	20,000	40	15,000	50	15,000	75
Margin contributed..	50,000	50	30,000	60	15,000	50	5,000	25
Common costs	30,000	30	12,000	24	9,000	30	9,000	45
Net margin (loss)..	$ 20,000	20	$18,000	36	$ 6,000	20	($4,000)	(20)

Period 2

	Total		*Product A*		*Product B*		*Product C*	
	Amount	*%*	*Amount*	*%*	*Amount*	*%*	*Amount*	*%*
Net sales	$100,000	100	$60,000	100	$30,000	100	$10,000	100
Variable costs	46,500	46.5	24,000	40	15,000	50	7,500	75
Margin contributed..	53,500	53.5	36,000	60	15,000	50	2,500	25
Common costs	30,000	30	15,450	25.8	9,600	32	4,950	49.5
Net margin (loss)..	$ 23,500	23.5	$20,550	34.2	$ 5,400	18	($2,450)	(24.5)

It will be noted that the total sales were unchanged from Period 1 to Period 2 but that the product mix changed so as to increase the sales of A and decrease those of C, leaving B unchanged. The

cost allocation method used reduced the net of A in percentage terms, although its volume increase produced the improvement in total *dollar* profit. B's net margin was reduced although there actually was no change in B's sales or direct (variable) costs. The percentage net loss for C *increased,* but this actually was a good thing for the switch of production from C to A bettered over-all results. In the illustration we see an example of a phenomenon in which two products show a lower percentage net profit and the third shows a larger percentage net loss, yet the total net profit percentage increased. Such cost allocation, in my opinion, is worse than useless. It is dangerous.

Thinking in Terms of Contributed Margin

But, you ask, what method should one use to allocate common costs to products? The answer, hard as it is for many accountants and the Bureau of Internal Revenue, is that there is no rational basis for allocating common costs and management must be re-educated to think in terms of margins contributed by sales over direct costs. Dividends and taxes are paid out of total profits and not from the profits of one product or one plant.

I can see some readers rising up in anger at this violation of a sacred "principle," but accountants violate this "principle" consistently in the use of "normal" overhead rates. Such rates are justified for pricing purposes in order not to force up unit cost in periods of low volume and so "price the product out of the market." What nonsense! This boils down to the fact that you are actually letting the market determine the cost by deciding what "fixed costs" you can stand after meeting variable cost. Why not be logical and concede that what you are trying to do in your price and output policy is to *maximize* the margin of revenue over variable cost and admit that fixed costs do not influence this. In other words, stop thinking that only the cost blade of the cost and revenue scissors cuts the cloth.

Product cost statements and product profit statements should contain only the costs required by the specific products. These can be controlled. But, you say, this viewpoint may result in showing a large margin for a product requiring expensive machinery and a small margin for one requiring little or no machinery. If the machinery is completely specialized, then I would recommend showing depreciation as a separate deduction *after* the direct margin is computed. Here I would deduct *all* the depreciation and not just

the "normal." The object of product costing is not only to show what margins *were contributed* but to guide management in pushing high margin items and deciding whether to contract or eliminate low margin items. Many products show a "loss" after their "fair share" of fixed and common costs. This usually starts a family ruckus because someone wants to kick them out and others insist they actually "contribute something to overhead." In the name of common sense, why not prepare the statements in the first place so as to show this contribution!

Keeping Attention Fixed on the Significant Factors

The test of any change in policy is whether or not it will improve the total profit situation. The only cost data relevant is that associated with the change and fixed costs, therefore, if they are really fixed, are not relevant. The cost accountant can show, by break-even or profit graphs, what a change in policy requires in order to constitute an improvement over the existing situation. He should, where price and volume changes are likely, point out to management the need for revenue data as well as for cost data. For products and departments he should emphasize controllable costs and should analyze fixed and common overhead costs in terms of the departments in which they originate, not in terms of production departments to which they may be allocated by one of several methods all lacking full rationality.

To summarize, the economic theory of rational management is concerned first with the problem of selecting the best price and output combination and, second, with keeping costs as low as they were expected to be and revenue as high as anticipated. The cost accountant should give a great degree of attention to controllable costs by products within a plant and be very careful, even reluctant, to allocate fixed costs and common overhead costs. He should emphasize the relationship between controllable costs and volume. A final word of caution which may be given here relates to percentages. It is only a coincidence if maximum total dollar profit is also the maximum percentage profit on sales, just as it is a coincidence if minimum average unit cost is achieved at the same volume at which marginal revenue equals marginal cost. The objective of management is properly directed to total dollar profit. The cost accountant should see through to this objective.

SPREADING OVERHEAD TO COST CENTERS ON THE BASIS OF STANDARD EARNED HOUR RATES

by CLARENCE A. DeLAND,
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A distinguishing feature of this procedural article on overhead distribution is a tabular display of the sequence of processes affecting the principal products and tying in with choice of the cost center as the unit to which to apply overhead. The bases of budgeting standard earned hours for cost centers, establishment of dollar allowances for overhead items, and the derivation of the cost center absorption rate per standard earned hour, are illustrated.

MANUFACTURING overhead can be distributed or applied to direct labor dollars, direct labor hours, or machine hours through use of one of the three following types of rates:

1. *An over-all percentage* applied to the total direct labor unit.
2. *A general departmental rate,* viz., turning department, drilling department, grinding department, applied to the direct labor unit for the respective department.
3. *A cost center or operation classification,* viz., drilling-milling machine group, drilling-drill press group, grinding-centerless grinding, grinding-internal grinder, etc.

The labor unit selected (dollars or hours) for use as the base for spreading manufacturing overhead can, of course, be the result of current determination of actual periodic compilations of the components of this base, or the result of a survey of past operations coupled with conservative estimates of future operations. Or a "standard" unit, deemed to be representative of the base can be established as the factor for accumulating overhead. The labor unit selected here for application of manufacturing overhead is "standard earned hours." The decision to apply overhead at so much per standard earned hour to cost centers rather than on a plant-wide or departmental scale reflected an intensive survey of the various practicable methods for accumulating overhead costs as they related to specific products and processes. The "cost center" method disclosed itself as much the most equitable solution to our particular problem.

MANUFACTURING PROCESS DATA SUMMARY

Small Bearings—Type 1

Type of Material and Source of Supply	*Labor Operations*
Part 1—End Plate	
This part is a "steel ring" stamping cut from steel tubing and is purchased from outside vendors.	1. Application of a cyanide bath located in the heat treat department.
Part 2—Rollers	
Cut from steel bar stock requisitioned from raw materials purchased by the company.	1. Turning-Brown and Sharpe automatic department. 2. Hardening- heat treat dept. 3. Sand blast (Dept.) 4. Grinding (Dept.)
Part 3—Stay Rods	
Cut from steel bar stock requisitioned from raw materials purchased by the company.	1. Turning-Brown and Sharpe automatic department.

Large Bearings—Type 2

Part 1—End Plate	
This part consists of a steel ring forging cut from steel tubing requisitioned from raw materials purchased by the company.	1. Turning—Sundstrand group. 2. Turning—Jones and Lamson group. 3. Radius and Chamfer—engine lathe group. 4. Drilling—milling machine group. 5. Drilling—drill press group. 6. Burring—burring machine group. 7. Cyanide—heat treat department. 8. Sand blast—sand blasting group.
Part 2—Roller	
Cut from steel bar stock requisitioned from raw materials purchased by the company.	1. Turning—single spindle Gridley automatic. 2. Radius and Chamfer—engine lathe group. 3. Nipping—nipping machine group. 4. Burring—burring machine group. 5. Harden—heat treat department. 6. Sand blast—sand blast group. 7. Grinding—centerless grinding group.
Part 3—Stay Rod	
Cut from steel bar stock requisitioned from raw materials purchased by the company.	1. Turning—Brown and Sharpe automatic department.

EXHIBIT 1

A quick look at Exhibit 1 will indicate the broad reason for this. Relating to only two out of four principal types of bearings, it at once makes clear the diverse operations applicable to individual products. Under these circumstances, use of company-wide or department rates seemed definitely inadequate recognition of operating facts.

An Incentive-Based Standard Earned Hour for Each Cost Center

As already mentioned, the procedure for applying overhead to the cost centers is based upon the utilization of a standard earned labor hour. This in turn is tied in with a wage incentive system. Earned hours are computed by multiplying the number of pieces produced (as shown on the job ticket) by the time study rate assigned to each operation. The standard earned hours multiplied by the operator's standard base rate results in the employee's earnings and also the standard earned hours for the various operations in the plant as a whole. In a further step, this information is transcribed to a tabulating card from which subsequent analyses are prepared giving a summary of all direct labor earnings and standard earned hours classified by individual cost center.

After accumulating the data on earned hours for a representative number of months, it was possible to utilize the statistics as a basis for establishing a standard earned hour for each cost center. The standard earned hour is the conductor used as a basis for transmitting the overhead of each respective cost center to the ultimate cost of sales. Exhibit 2 is submitted as a means of conveying to the reader the procedure used in establishing standard earned hours for various cost centers.

DERIVATION OF STANDARD EARNED HOURS BY COST CENTERS

Cost center	Cost center No.	Earned hours of months per analysis of payroll						Standard activity		
		Jan.	Feb.	Mar.	Apr.	May	June	Total	As average	As budget	Remarks
Cutting	1	500	450	500	500	550	550	3,050	500	525	
Boring	2	300	250	300	400	350	350	1,950	325	350	
Broaching	3	500	400	400	400	450	450	2,600	425	400	
Turning	4	500	500	550	550	500	500	3,100	500	525	
Trimming	5	400	350	400	450	450	400	2,450	400	425	
Totals		2,200	1,950	2,150	2,300	2,300	2,250	13,150	2,150	2,225	

Note—All figures used are assumed and are no part of any particular plant or industry.

EXHIBIT 2

The figures naturally do not reflect any particular situation but are illustrative only. However, the procedure is faithful to sound practice. In establishing the standard earned hour for each cost

center, a review should be made of payroll data in the past, the present, and with respect to future periods as a means of providing the basis for accurate judgment in handing down the decision on the proper standard earned hour for a particular center. The first step is to enter on a schedule like that in Exhibit 2 the titles of the cost centers in their proper sequence, together with the number of standard earned hours for each month as provided from supplementary payroll data.

On the illustrative figures, the average number of hours is reflected for each cost center. If it is desirable to adjust the average to an estimate or budgeted number of hours, this can be achieved as indicated in the final column of Exhibit 2. The form and method can be changed to suit the requirements of specific plants.

Cost Center Expense Budgets Keyed to Prospective Activity

The presentation of the budgeted activity base for overhead distribution gives half the picture. The other half is the budgeting of the various categories of expense in dollars for each cost center at this activity so that (among other things) the relationship of budgeted outlay to budgeted activity may produce the absorption rate to be applied in the mechanics of accounting and so that, as the months go by, variances may be noted and explained.

However, there is no reason to carry forward the purely hypothetical figures shown in Exhibit 2 and in illustrating in Exhibit 3 the budgeting of dollar outlay for indirect labor, the punching center has been selected. Indirect labor includes salaries of super-

INDIRECT LABOR EXPENSE RELATED TO BUDGETED ACTIVITY LEVEL

Cost Center No. 1 Punching Center

Date ..... Activity* ..... Standard Hours

Particulars	*Number of employees*	*Standard hours per week*	*Standard hourly rate*	*Standard earnings*	*Remarks*
Foreman	1	40	$1.50	$ 60.00	
Assistant foreman..	1	40	1.25	50.00	
Setup men	2	40	1.00	80.00	
Inspectors	2	40	1.00	80.00	
Stock Movers	1	40	.75	30.00	
Timekeepers	1	40	.70	28.00	
Sweepers	1	40	.65	26.00	
Total indirect labor.				$354.00	

* Enter here the number of standard earned hours derived from setup illustrated in Exhibit 2.

EXHIBIT 3

vision (plant manager, superintendent, and foremen), time clerks, watchmen, sweepers, inspectors, trucker, stock movers, etc. Another expense account which is significant in most every manufacturing industry is that of perishable tools. Exhibit 4 is designed to show the various types of tool charges as well as reflecting the standard hours for a period of several months. The data presented is, of course, supported by subsidiary records such as work sheets listing the detail of requisitions, tool orders, etc.

PERISHABLE TOOL COST RELATED TO BUDGETED ACTIVITY

Cost Center No. 1 Punching Center

Date ..... Activity* .....Standard Hours

Particulars	*Jan.*	*Feb.*	*Mar.*	*Apr.*	*May*	*June*	*Standard budget set*
Standard hours	500	450	400	550	650	600	
Requisitions from stock..	$250	$200	$150	$250	$300	$250	
Summary tool orders....	100	100	100	150	200	200	
Direct purchases	200	150	150	200	200	200	
Totals	$550	$450	$400	$600	$700	$650	

* Enter here the number of standard earned hours derived from the setup illustrated in Exhibit 2.

EXHIBIT 4

It is not to be supposed that a separate rate per standard earned hour is developed for each expense of each cost center. Such detailed rates could be developed but would serve no purpose. All budget figures for each cost center are added as indicated by the side captions on Exhibit 5 and worked into a single cost center overhead rate per standard earned hour as total overhead divided by budgeted standard earned hours. The categories shown include fixed charges and service department expenses. The remainder of this paper is devoted to brief explanations of the basis of assigning or distributing these two classes of costs in budgeted amounts to the separate cost centers where they form a part of total budgeted overhead for rate determination.

Allocating Payroll Related Costs and Fixed Charges

A summary sheet similar to the illustrations shown in Exhibits 3 and 4 should be used as a working model to support the computed amount of each type of expense account to be allocated.

Overtime premium can be set up on a form similar to that used for indirect labor. Compensation insurance and payroll taxes can be associated and computed from the payrolls allocated to each respective cost center.

COST CENTER OVERHEAD BUDGET SUMMARY AND RATE DETERMINATION SHEET

Cost Center No. ..... Department .....

Date.....

Variable Expenses

Indirect labor	
Overtime premium	
Compensation insurance	
Payroll taxes	
Oils and greases	
Perishable tools	
Grinding wheels	
Power and light	
Water	
Repairs	
Group insurance	
Total variable expenses	

Fixed Expenses

Property taxes	
Insurance	
Depreciation—buildings	
Depreciation—machinery	
Depreciation—tools	
Total fixed expenses	
Total variable and fixed expenses	

Service Centers—Expenses

Inspection	
Receiving department	
Tool department	
Maintenance department	
Shipping department	
Total service centers—expenses	
Total factory overhead	
Activity ..... st. hrs.	
Overhead rate per st. hr.	
Per cent overhead to direct labor	

EXHIBIT 5

Insurance costs pertaining to buildings can be allocated according to floor space occupied. Insurance costs on machinery and equipment should be charged pro rata to each cost center based upon the dollar value of machinery invested in the respective centers. Insurance costs on product inventories can be charged

direct to a receiving and storing department (a service center) and in turn be reallocated upon the distribution of the service center to the various production centers. Distribution of property taxes should be made on the basis of floor space occupied by each cost center. Depreciation on buildings should be charged to the building center (a service center) which will in turn be redistributed to other centers on the basis of floor space occupied. Depreciation on machinery and on permanent tools should be charged pro rata to each cost center as with insurance on machines.

Water and Power Cost Distribution

The distribution of water consumption should not present any difficulty where a plant has individual meters for each cost center. However, where there are no meters available, then estimates will be in order. These estimates should be furnished by the engineering department or some individual who is qualified to make such a calculation. A further comment is made to the effect that if the water expense is of a nominal amount it might be more practical to classify it as a part of general factory expense distributed to other cost centers.

Electrical energy is utilized in many different ways and for various purposes in the average manufacturing plant. It is present directly in the motors associated with different machines. It is utilized in processes such as arc welding, plating, etc. It is also used as a conductor of heat in liquid vats and heat treating furnaces. Last but not least, it is present for general lighting.

An accepted method for distributing electric current costs is on the basis of horsepower hours. Total horsepower hours are obtained by preparing a schedule of the horsepower hour capacity on each motor located in each cost center throughout the plant and, at the same time, multiplying the horsepower capacity by the number of hours the respective equipment is in operation each month. It is felt that this horsepower hour calculation should be established on a standard activity basis for each center.

Service Center Costs

The expense of the receiving and storing centers is distributed to production centers on the basis of the tonnage handled for the class of materials affecting each group of machines. The costs pertaining to the inspection center are redistributed to the production centers on the basis of percentage of direct labor incurred by each production center to total direct labor. Maintenance center costs

are distributed on a basis similar to that described below in respect of the distribution of the tool room center. The costs of operating the shipping center are distributed to production centers in the same manner as inspection costs.

Job orders which are issued to accumulate detail tool costs relative to services rendered to the various cost centers could be charged direct to the center being serviced but, due to management's desire to have "under one roof" the cost of operating the tool room, all expense must first be cleared through the tool center. At the close of each accounting period, the tool room center is credited with the cost value of all job orders completed during the period with an offsetting entry to the various centers for which work was performed as indicated by the specific job orders. Any general expense remaining in the tool room center which has not been charged out in the form of job orders is prorated over the various cost centers in proportion to the job order work.

Conclusion

In this article, we have developed the situation of an industry in which standard earned hours applicable to the budgeted activity level in each cost center appeared to provide the most equitable basis of expressing the overhead rate for each cost center. Some detail of technical operations was first given for purposes of orientation. The general procedure for deriving a budget estimate of standard earned hours for a cost center was described and illustrated, as was the method of budgeting the principal expenses in terms of the prospective activity level. Preceding a series of brief explanations of allocations of fixed charges and service department expenses to cost centers, there was given in Exhibit 5 a pro forma statement applicable to any cost center and showing full detail of overhead items and setup for calculation of the cost center overhead rate as the quotient of total budgeted overhead divided by budgeted standard earned hours.

While the successive steps portrayed in this presentation have necessarily been accompanied by exhibits containing purely hypothetical figures, these steps have a background throughout of experience in the bearing industry where they have been proven practicable. It is none the less true that each company must take stock of its own situation in adopting or adapting particular methods. There are no ready-made procedures and one company's experience can be only suggestive with respect to others.

PRACTICAL INTERNAL CONTROL—A CASE STUDY IN THE MOTOR CARRIER INDUSTRY

by PHILIP L. ANDERSON,
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Coverage of control procedures in use in a motor freight carrier and applicable to revenue, receivables, and payrolls as well as to gasoline and tire and tube outlays, is afforded by this paper. In connection with revenue control, some detail of order, pickup, terminal, and building procedure is given in readable fashion. The question of practicability of mileage control records for carriers is taken up.

BEFORE delving into specific applications of accounting controls as related to the motor carrier industry it would probably be well to review what we mean by controls as related to industry as a whole. Effectiveness of the system of internal control measures the reliability of the books and records for whatever purpose they are used. This is recognized in the public accounting field as well, and the external auditors commonly determine from review of the system the extent to which they must test the underlying records to confirm the accuracy of the summary records from which financial statements are prepared.

Internal control is fundamental and it can be activated by a variety of hand or a variety of machine methods each having its own application depending upon the size of the enterprise to which it will be applied and the amount of statistical information to be gained as a by-product of the actual recording of transactions. Such information may be used by management or may be necessary, as in the case of the motor carrier industry, to keep governmental agencies informed. In planning for control it must be borne in mind that at least two people should be involved in any transactions but from a different angle. If one person is handling all accounting and office functions, such as opening the mail, depositing the cash, mailing statements, handling the receivables and handling the general ledger, the reliability of the records cannot be as complete as when different persons are handling these functions. Thus, the larger the organization the more it lends itself to control. However, this statement should be coupled with the

thought that larger organizations with proportionately greater volume of assets and flow of revenues and costs, are relatively more in need of such control.

Revenue Accounting Control

Motor carriers have in the past been relatively small organizations and even today this statement is true. They have found that a careful allocation of duties of two persons will give a start towards control and, in practice, the movement of freight between two points lends itself readily to control because of the number of people, including operating personnel, necessarily involved. On the other hand, the dollar per bill rendered is small compared to most other organizations and economy in handling accounting becomes of utmost importance. The common carriers of the motor carrier industry have been likened to five and ten cent stores operated on a charge account basis. Thus, revenue accounting control is our first subject. This subject has several parts and effective control has a like number of benefits:

1. We account for the cash which is due us.
2. We account for the collection of our revenues.
3. We develop information which is important in the operation of our business.

The problem is to coordinate and cross-check in an organized and efficient manner the activities of the numerous individuals involved in the accounting for a movement of freight from the time it leaves the shippers dock until the cash is eventually collected and the transaction is closed. Numerous procedures are available to do this, both through manual and machine methods. I believe the machine methods are particularly adaptable when considerable use is made of statistics by management. One method of handling revenue accounting, designed primarily for common carriers cutting relatively large numbers of bills, each of which produces a small amount of revenue, will be outlined.

Pickup, Waybilling, and Driver's Collections

At one time the manifesting method under which each waybill was listed and checked off the list when paid was in general use. In recent years more and more carriers have reverted to the pull-file method. A form of this method is the one which seems preferable. Another point at which some differences of viewpoint occur relates to whether the terminal or the general office is to be

charged with the responsibility for collections. The flow of responsibility for collection and control under the system under discussion takes the following course:

1. The driver makes collections from customers not on an approved credit list.
2. The cashier checks the driver.
3. The cashier is checked by the auditors.
4. The auditor is accountable to the credit manager or the finance officer.

But to start at the beginning! The dispatcher receives a call that the A Company has shipments ready and assigns the pickup to a driver in the area involved, who signs the original bill-of-lading and picks up the shipping order copy of the bill-of-lading and brings it and the freight to the terminal. At this point control is lost temporarily if one of two conditions happen. First, the driver may not pick up the freight as indicated on the shipping order turned into the terminal office. This can be controlled through a freight checking system which is an operating as well as an accounting problem. However, if a driver signs the bill-of-lading and fails to pick up either the freight or the shipping order, control is really lost. I know of no way that this can be controlled without the dispatcher obtaining all information on a shipment from the shipper at the time of the pickup order. This would, of course, be impractical and deviations from 100 per cent control seem bound to occur in a business with operations so far flung and with the "production line" handled by men who are out of immediate control of supervision. The same possibility exists on en route pickups delivered en route. These can be controlled only through such dispatch records as are available.

Once the freight has been picked up, checked into the terminal, and the shipping order left with the rate and billing departments, we are ready to produce that most important document, the waybill. From the shipping order, nine copies of the freight bill are cut. The following is a list of bills applicable to a system employing terminal collection responsibility:

1. Original freight bill
2. Cashier's copy
3. Delivery receipt
4. Duplicate freight bill
5. Terminal copy
6. Junction settlement copy
7. Waybill copy
8. Accounts payable copy
9. Auditor's copy

All bills are prenumbered with a prefix designating the billing station. We believe this is most important and all voided or unused bills are accounted for. The number eight and number nine copies are the general office control copies and are forwarded to general office as soon as prepared. We control our drivers through a delivery and cash receipts statement. When the driver leaves on his deliveries he is charged with a certain number of bills and when he returns is given credit for the return of his delivery receipts and is checked to see that he turns in cash on customers not on the approved credit list. It may well be mentioned here that a missed c.o.d. is costly since the customer may be a poor credit risk and even when eventual collection is made, it is an expensive proposition. It can be pointed out that the tariffs provide a peculiar, distinctive, and required type of bill-of-lading in connection with c.o.d. shipments. Use of this would help in connection with the fact that the shippers frequently note the c.o.d. charge almost anywhere on the shipping order and many times it is obscure and covered by additional writing. If the responsibility were placed on the shippers to clearly indicate that the shipment was a c.o.d. I am sure the billing clerks, who are doing a high-speed, pressure operation, would miss far fewer than at the present time.

Centralized Control of Terminal Collection Responsibility

Our *control* over collections as a whole is maintained in the general office with major *responsibility* lying with the terminals. Reasons for using terminal collection, apart from the question of controls, are:

1. Easy collections
2. Customer contact
3. Use of phone
4. No statementing
5. Seven day credit limit

The number nine copies are checked upon receipt in the general office to see that all the prenumbered bills in the series are accounted for. The freight charges due for collection are tabulated from these copies and arranged by terminal responsible for collection and an appropriate debit is made to accounts receivable for freight. Simultaneously, those bills on which payables are due connecting carriers are tabulated and the appropriate credit is made to interline accounts payable. The difference, of course, represents freight revenue and the appropriate credit is made to that account. The number nine copy is filed by station charged with

collection and further identified by origination and destination station to provide ease in deleting from files when paid. As a matter of control we have had the traffic department circle the amount to be collected to clarify the amount charged to the control. The number eight copy is similarly set up as a payable file. At this point, all of our billing has been accounted for and our detail file agrees with our control.

Once a bill is in the file in the manner described, it is regarded as an item controlling the transaction and can be pulled only when paid or on authorization of the credit manager, and his authorizations for cancellation, transfers, and deletions are reviewed by an officer of the company. At the same time, terminals are setting up the number two or cashier's copy of the bill in their file which will, of course, agree with the general office file. It is this set of counterpart files which controls our freight revenue accounting. At the end of each accounting period, the general office prepares a list of outstanding receivables billed in the prior period and submits this file to the terminal for checking against their files. They must comment on each bill as to ultimate collection, steps taken to effect collection, or whatever they may know about the outstanding amount. Our traveling auditor on unannounced trips at unstated intervals checks the terminal's files with the general office files and makes test calls on scattered items to effect collection or test the accuracy of the terminal's reporting.

As the terminals make collection, they deposit intact any checks or cash received. They are not permitted to use these funds for any purpose. We provide our terminals with checks which they may draw on a special account to effect interline settlements. Upon making a collection, the terminal clears the cashier's copy from the file and prepares a cash report showing the total amount collected on freight charges, assessorial charges such as storage, c.o.d. fees, etc. If a bill is paid in an amount other than shown as original billing, the amount collected is shown on the cashier's copy and circled. If paid in the same amount the original amount is circled. An adding machine tape is run of these bills, separate tapes being run for tax collections, c.o.d. fees, storage, and other charges. These tapes, the cashier's copy of the bills and a list of c.o.d.'s remitted to us are all attached to the cash report along with the checks and a listing of the c.o.d.'s made payable to shippers. As further support, the terminal mails to general office a receipted copy of the deposit slip in support of the bank deposit.

Completing Revenue Accounting at the General Office

When the general office receives the cash report, a check is drawn on the terminal bank for the amount of c.o.d.'s included and these funds are deposited in a separate c.o.d. bank account. The remainder is also drawn by a check on the terminal bank and deposited in our general purpose bank account for company use. The complete cash report is turned over to the revenue accounting department where the cashier's copies of the bills are matched with bills in the control file. These are then pulled. Increases or decreases in amounts due as a result of changes in waybills prior to collection are recorded on an increase or decrease journal in order that our detail records will agree with our control account. A separate cash book is maintained by the chief clerk of revenue freight accounting department who properly distributes the collections to accounts receivable, revenue (increases or decreases at time of payment), c.o.d. fees, storage, rents, detention charges, transportation tax, etc.

At the end of each period, a tape is taken of all outstanding charges and this tape should agree with the controls. Actually deviations will occur and it has been generally accepted that a one-tenth of one per cent deviation under this method is acceptable and that checking (under the pull-file system in use) or the use of a manual posting system are impractical from a cost angle. It is extremely difficult to determine whether general use of a system which allows the loss of control should be acceptable. We must go back again to our original statement that we are handling a large volume of shipments with a low revenue per bill. The higher the revenue per bill the lesser deviation should be allowed. Again I state that the only reason we make this concession to loss of control is the cost involved.

Were the method outlined above applied to machine methods full control could be obtained at no extra cost assuming the carrier could and would make use of the operating statistics produced by the machines as a by-product of revenue accounting control. Some of these by-products would be revenue weight and direction of traffic by customers, shipments as divided by weight class, 100 per cent accuracy on directional flow of traffic, and ease and speed in obtaining outstanding accounts, thereby effecting better collections. There are other types of useful information which could be made available under these conditions.

To sum up what has been said on this side of the picture, the most important factors in establishing adequate revenue controls may be considered as:

1. Control of bills at terminal before release to drivers.
2. Accurate checking of drivers.
3. Prenumbered freight bills.
4. Duplicate terminal and general office files.
5. Careful checking by traveling auditors at unstated intervals.
6. Depositing funds intact.
7. Close attention to follow up of any irregularities discovered.

Basically the use of pull-file methods for revenue accounting, one variant of which has just been described, was started before punched card applications were made to motor carrier accounting. However, I feel that this type of equipment is basically adaptable to the motor carrier industry and that numerous conversions to machine methods will be made in the near future, adding to the many successful applications already in existence in the industry.

And Then There Is Payroll Control

What about the important matter of payroll controls? In our industry, since better than 50 per cent of revenue is returned to employees in the form of wages and since we act as a collection agency for governmental agencies and other bodies such as unions, we should be most careful that we establish adequate controls over payroll disbursements. Many methods are available to which dishonest employees may resort in manipulating payrolls. The following are a few ways which have been used to make a dishonest dollar and the system we devise must discourage them.

1. Planting fictitious employees on the payroll.
2. Increasing total amount of payroll by overfooting.
3. Carrying the names of former employees on the payroll after their resignation or discharge.
4. Appropriating unclaimed wages.
5. Showing earnings of employees in excess of actual.
6. Failing to record deductions from employees' wages.

First of all, a few generalizations may be in order. All hourly employees should be required to punch time clocks. This is basic

and should be the starter of an adequate payroll system. The employee should be required to sign his time card to make it a certification of hours actually worked and, later, a basis of verification in connection with any indications of fraud. It seems essential also that all disbursement for payrolls be made from the general office. Warehousemen, city drivers, and terminal personnel should be listed on a payroll summary sheet by the terminal with the amount of straight and overtime indicated, the rate of pay, and the gross amount. The payroll should be signed by the terminal manager indicating that he has examined it and found it to be in order. This thrusts a major responsibility on him. Incidentally, it is only good business to have the terminal manager review the payroll, as it is his major means of effecting cost savings. After the terminal payroll has been prepared it should be forwarded to general office with the time cards. There the payroll is completely checked by general office personnel, the numerous deductions made, and the checks issued.

In our company each roadhaul driver works on a travel order which he is given by the origin station. He punches his time at a designated time clock and has his travel order signed by a designated individual. He also receives at this time a manifest of his load. At destination he again punches the time on his travel order and has it noted by the proper party at that point. After he has completed his run, he mails his travel order and manifest to general office. These become authorization for the payroll department to issue his pay check. The payroll department, after making the appropriate deductions, mails the checks to the terminal manager for distribution to the individuals involved.

In order to control the six vulnerable points previously mentioned in connection with payrolls, effective procedure may be said to require that:

1. An employment application blank be supplied and applicants be checked on statements made in their application.
2. Periodic unannounced spot checks be made on employees working, all separations since the previous payroll be scrutinized, and cases of absentees noted at the time of the checkup be followed to a conclusion.
3. All payments be made by check and all payroll footings and extensions be checked by someone other than the party preparing the payroll.

4. All unclaimed wages be returned promptly to the general office.
5. The functions of preparing the payroll be distributed among as many people as possible.
6. Someone from general office (or outside auditors) handle the distribution of payroll checks at unannounced times.
7. Payouts to be deducted from payrolls be handled through a separate control account and the control balanced and checked regularly.

In these and other methods set up to achieve control, it is most important that any deviations or abnormalities discovered be followed to a conclusion completely satisfactory to the examiner, for seemingly minor items may lead to startling discrepancies.

Control of Gasoline Useage

Another disbursement which must be controlled because of its size as an outlay and because poor handling can result in losses through dishonesty or waste is gasoline. Most organizations find it practical to have their own pumps at designated points. It would be well, in those cases, to use control meter types of pumps if possible, and, under any circumstances, prenumbered tickets for issuance of gasoline. These tickets should be controlled centrally at the point at which disbursement for gasoline purchases is made, and daily stick readings of gasoline tanks should be furnished to the central clearing authority. Tickets issued either at company pumps or for purchases on the outside should include the following information:

1. Vehicle number.
2. Date.
3. Approximate time the gasoline was put in the vehicle.
4. Speedometer reading.
5. Driver's signature.
6. If at a company pump, the name of the employee who issued the gasoline.

By a simple sort, the tickets may be broken down to individual vehicles and passed to an individual vehicle gasoline record. From speedometer readings or other knowledge of use of the vehicle as supplied by the operating department, discrepancies might appear which would point to dishonesty on the part of a particular employee or waste, either through improper method of operation or the operation of an improperly serviced power unit. These

are, perhaps, the minimum controls which should be established and, if the operation is such that use of a vehicle can be classified, the matter of gasoline can be tied in to individual vehicle cost records. This type of record might be of considerable use in many enterprises.

The Question of Mileage Control

Accurate mileage records are very difficult to obtain on a controlled basis. In our organization, it is a fairly simple matter to obtain the miles traveled by roadhaul tractors or roadhaul trailers, as we use the device known as a travel order mentioned in connection with payroll control, which indicates the trip which a particular unit has made and underlies our roadhaul payment, basically determined on miles traveled. However, when we get into the subject of city tractors and city trucks, our problem becomes much more complicated. The question arises whether the hours of service of a particular unit is or is not a better criterion than mileage for establishing a cost basis. Most organizations that I have come in contact with have had difficulty in maintaining speedometers in working order, and so have lost for control purposes the most common device for measuring power miles. We have adopted the policy of making spot test checks to determine the approximate miles that city vehicles are traveling. A considerable number of operators obtain their mileage for city units through estimates furnished by the city dispatch department and which are estimates based on dispatch records.

From these comments, it may perhaps be gathered that city miles data is of doubtful value as compared with hour of service units which can be readily obtained in an accurate way. It would seem that the solution of the general mileage control problems would be to maintain intercity costs on a mileage basis and city costs based on hours of service. In Michigan, the state in which we operate, and in numerous other states the states assess fees on intercity miles. As in so many instances, where control is striven for, the tabulation of intercity mileage turns out to serve a dual purpose.

Control of Tires and Tubes

One of the largest expenditures of motor carriers and one in which the per unit cost is particularly high, involves the purchase of tires and tubes. Upon the receipt of a shipment of tires it is

suggested that they be branded with the company name and assigned a company number which would appear on both sides of the tire. The reason that branding on both sides of the tire is suggested is that inspection of tires on a vehicle having dual wheels will be facilitated in this way. One person should be responsible for the entire tire stock. As tires are received and numbers assigned, it is well to set up duplicate card files, one a numerical file showing the tire numbers and the other file indicating the serial numbers of the vehicles on which installed, with indication also of tires which are a part of stock. In connection with such records, a form should be devised for reporting the serial number of tires put on and pulled off of vehicles.

Again we come to the question as to whether or not records should be maintained so that knowledge can be accumulated as to the effective mileage—this time of particular brands of tires. We have felt that type of tire use is a much more important factor in determining the ultimate mileage than considerations of tire construction. In other words, if a tire is continually overloaded, its life will be much shorter than when used on a run on which the weight factor is not as heavy. In the operation of the average common carrier, where tires will be put to many different types of uses and it is desirable to compare the serviceability of various constructions and makes of tires, one would probably accomplish more by assigning tires for which comparison is desired to comparable runs. Such a test can be used as a basis for determining the type of tire best to purchase. Accurate information as to the reasons for scrapping tires at the time this is done should be retained carefully and given a thorough examination. From this type of information it would be possible to determine whether or not, on the whole, tires were being scrapped because of overloading or other costly types of operation. As to fraud in this area, possibility might exist in the sales of scrap tires. We believe that a person other than the individual in charge of tires should be present at the time of scrap sales, examine the tires along with the custodian, and report the company's assigned tire number. All of these records should be controlled through the general office and by a person other than the tire custodian.

Does Internal Control Pay?

The question is often asked, "does internal control pay?" and when not asked, it frequently exists as an unspoken doubt. I feel

that internal control, so devised and applied as not to overburden the company with a tremendous overhead and properly set up, will operate in an organized and efficient way and add a negligible amount to operating cost. In many cases internal control is merely a matter of achieving in a satisfactory way results which must be obtained in some form, whether on a controlled or uncontrolled basis. Of course there cannot help but be *some* cost attributable to internal control. It is in part a form of insurance cost, expended as a deterrent to the dishonesty of employees. In addition, if discrepancies of various types which may appear are followed systematically and assiduously such control should uncover dishonesty stronger than the deterrent. However, to me, the main point involved is that effective internal control establishes reliability of accounting records for cost and management control. Therefore, if cost and management control are necessary, internal control is likewise, for the sake of sound, economical, adequate, and properly maintained records and procedures. Not only does internal control pay, but no organization of substantial (or even moderate) size can be operated at maximum efficiency without it.

COMING ARTICLES

In the *N. A. C. A. Bulletin*, February 15, 1949

Break-Even Analysis—Common Ground for the Economist and the Cost Accountant

by John H. Kempster

Ready Determination of Economic Lot Size in Small and Large Companies

by Norman T. Harrison

Daily Report Basis for Planning and Control in the Flour Milling Industry

by K. E. Linnenkohl

COST CONTROL FOR SPONSORED RESEARCH IN A UNIVERSITY

by NORMAN N. BARISH,
Assistant Professor of Administrative Engineering and Secretary of the College of Engineering, New York University, New York, N. Y.

Records established by one college of engineering, supplementary to the university accounts, to provide research project directors and university management—as well as governmental or industrial sponsors—with prompt information for control of research costs and revisions of budgets or programs, are described in this article and presented in exhibit form. These include the project budget, monthly project and summary reports, and cost ledger.

GOVERNMENT and industry were making increasingly great demands on the research facilities of the College of Engineering of New York University at the conclusion of World War II. Within a comparatively short time, the college found itself with research contracts running into relatively large sums of money. To effectively administer this research program, a Research Division was established in the College of Engineering. To successfully control, account for, and recover the cost of this research, it was necessary to establish a new procedure within the framework of the university accounting system.

The new procedure, as described in this paper, has provided the necessary control of expenditures, follow-up on billings, and historical cost analyses on each project and on research operations as a whole. It is believed that this type of procedure is applicable to many commercial organizations performing contract research as well as the research programs of other colleges. It is especially adapted to the operations of a research organization which is part of a larger institution not organized solely for the performance of contract research or development work.

The adoption of this new procedure was made necessary because the existing university accounting system was designed for the academic operations of the university and was found to be inadequate for the performance of all the required cost control functions of the College of Engineering research program. It was,

after all, geared to academic requirements. Changes within the existing system were made difficult due to the overload in academic activity caused by the postwar bulge of students. To handle this cost control and invoicing problem without the establishment of an elaborate and expensive system and to have it operate within the framework of the existing university accounting system, the system described in this article was evolved by the Statistical Office of the College of Engineering.

What the System Is Designed to Do

The comptroller of the university continued to handle the payroll, disbursement, and purchasing functions and maintained control accounts on each project. All the official accounting and procurement records thus remained with the university comptroller. Our problem, then, was to set up a system on the college of engineering campus which would operate in coordination with this centralized university accounting control and would provide a basis for adequate budgetary control of research operations. Our principal specific objectives were:

1. To limit the purchases and other expenditures of the research personnel to required items within budget limitations for which direct or indirect reimbursement can be obtained from the sponsor.
2. To provide the financial information required for effectively controlling research costs.
3. To promptly and accurately bill governmental and industrial sponsors for actual research costs.
4. To provide each sponsor with such financial and cost reports as he required.

The Starting Point: A Budget Approved by Project Sponsor

During the negotiations with the sponsor of a proposed research contract, a budget is usually prepared. After the contract is formally executed, the university appropriates money to finance the project on the basis of the budget. This budget may be changed as the project progresses and as unforseeable circumstances arise. If the total authorized expenditure is to be increased, the approval of the sponsor is, of course, necessary. An example of such a budget is shown in Exhibit 1.

To fulfill the first objective of limiting expenditures to required, reimbursable items and to insure the correct accounting alloca-

PROJECT BUDGET*

Forgaro Project—Account 48-22
9/1/47 through 8/31/49

Income	
Provided in Contract M3846	$75,000
Expense	
Code 1000—Salaries (professional)	$35,000
1500—Salaries (laboratory)	10,000
1030—Travel	1,000
1200—Equipment	4,000
1300—Supplies	10,000
4860—Overhead	15,000
Total	$75,000

* Hypothetical data.

EXHIBIT 1

tion of the charges for these items, all requisitions for personnel, supplies, etc., are routed through the statistical office prior to submission to the university purchasing department, personnel department, etc. The statistical office checks each requisition and, if it is an admissible item, it is approved and coded for correct accounting. When required by contract or arrangement with the sponsor, special permission is obtained by the statistical office for certain categories of expenditures.

Cumulative Fiscal Report on Each Project

The comptroller of the university issues the official monthly tabulating control sheet for the control account for each project. These control sheets list all charges and credits against the account as recorded in the university accounting offices. The items on the control sheets are identified by requisition and order numbers. However, these control sheets, are not designed for use in research cost control. They are not easily understood by research personnel, do not have the expenses classified in required form, and cannot be as current as is required for good fiscal control. To control research operations effectively, it is necessary that the director of each project have a monthly breakdown of his expenditures. To provide the project director with this current fiscal information, a more readily understandable form of Project Fiscal Report is issued monthly for each project. As shown in Exhibit 2, this report gives a breakdown of the expenditures for the previous month and the balance of funds remaining in the contract.

PROJECT FISCAL REPORT
January, 1949

Contract No. M 3846 Title: Forgaro Project
Project No. 1298

	Total to end of previous month	*Expended this month*	*Total to end of this month*	*Estimated for next month*	*Estimated for following month*
Salaries and wages...	$18,553.72	$3,906.48	$22,460.20	$ 4,000.00	$ 4,200.00
Overhead	4,226.84	792.32	5,019.16	850.00	900.00
Travel	201.10	62.87	263.97	65.00	65.00
Materials and Supplies	1,496.17	687.96	2,184.13	1,000.00	1,000.00
Commitments*	2,106.31	832.27	2,938.58	.....	.....
Total	$26,584.14	$6,281.90	$32,866.04	$ 5,915.00	$ 6,165.00
Cumulative total.....			32,866.04	38,781.04	44,946.04
Contract amount			75,000.00	75,000.00	75,000.00
Balance remaining...			$42,133.96	$36,218.96	$30,053.96

* This item includes commitments for equipment and supplies and also actual expenditures for same which have not yet been recorded in the official accounting offices of the university.

Date Feb. 10, 1949

EXHIBIT 2

The fiscal report, in addition, gives an estimated projection of expenses for the following two months. This projection serves two purposes. First, a copy of this report is sent to the governmental or industrial sponsor of the project when this information is required for its guidance and use in planning. The sponsor is very frequently interested in knowing the expected rate of operations in the immediate future. Second, it informs the project director of the balance of funds he can expect to have available for expenditure two months hence. These estimates of future expenditures also provide a check on the project director and the statistical office. Unless otherwise informed, the statistical office will use the original or revised budget for the project as its guide for predicting expenditures for the succeeding months. Since the project director receives a copy of the fiscal report containing the predictions, he is thus prompted to inform the statistical office of any required changes, within his knowledge at the time, in plans for future operations.

The Summary Report of Research Operations

For administrative and over-all cost control purposes, a summary financial report is also issued each month in a form as

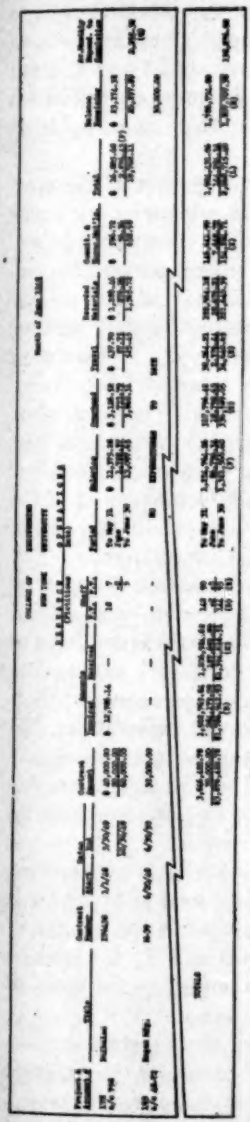

EXHIBIT 3

shown in Exhibit 3. From this report, the director of the research division and the dean of the college can keep their fingers on the financial pulse of research division operations.

All research projects being conducted in the college of engineering are listed in this report. To provide continuity of the summary figures and to promote ease of analysis of past operations, all projects with unexpended authorized funds are listed, regardless of whether or not there is any activity during the month. Also, projects which are completed during the fiscal year (July 1 to June 30) are carried on the report until the next fiscal year. In this way, the total operations for the year or any portion of the year with respect to any of the summary figures shown on the report can be easily determined by subtraction of the relevant totals. At the close of each fiscal year, the totals are adjusted for the completed projects which are then dropped from the report.

For example, if it is desired to ascertain the total overhead earned from July 1, 1947, through March 31, 1948, the total overhead to June 30, 1947, as shown on the July 1947 summary report is subtracted from the total overhead to March 30 as shown on the March 1948 summary report. However, if completed projects were dropped from the report each month, it would have been necessary to add the monthly overhead earned in each of the months to get a nine-month total. If it is desired

to know the overhead earned from April 1, 1947, through March 31, 1948, then it is necessary to subtract the overhead total to March 31 on the March 1947 summary report from the overhead total to June 30 on the June 1947 summary report and add this difference to the amount determined in the previous calculation for the overhead earnings between July 1, 1947, and March 31, 1948.

In use, the completeness and orderly arrangement of the operations report renders it easier reading than summaries containing like information are commonly expected to be. However, for convenience of reference this and the next several paragraphs contain symbols which have also been applied to columns on Exhibit 3 to facilitate rapid exposition of its outstanding features. The rate of operations during the previous month is determined from the report (L) which indicates any trend and/or seasonal patterns in total dollar volume of operations. The total unexpended balance remaining on all contracts (M) is compared with this current rate of operations to ascertain the average number of months of unfilled contract research on hand at the present rate of operations. The overhead earned during the month (G) can be compared with the current rate of overhead expenditure.

The difference between the total invoiced research (B) and the total received (C) indicates the volume of accounts receivable for research work. The difference between the total expenditures on the contracts (L) and the total invoiced costs (B) indicates the total amount of unbilled expenditures and commitments. Subtracting the total commitments and unrecorded expenditures (K) from this figure gives the total unbilled expenditures which have been recorded in the accounting office. This last figure can then be compared with the rate of operations (L) to determine the average monthly lag in the submission of invoices.

The report also makes available data on the ratio of travel expense to direct salaries (H/F), both the past total to May 31, and the current month expenditures. The changes in the number of full time and part time staff employees (D and E) are likewise made available. These are just a few examples of the kinds of summary information which the report provides.

In reviewing each project in the report, the financial status is portrayed as succinctly as possible. In particular, the average monthly expenditure that can be made to complete the project within the budget and the contract (Q) is compared with the total

DETAIL SHEET FOR EXPENSES WHICH MUST BE ESTIMATED BY STATISTICAL OFFICE AT TIME OF RECORDING

Account 794—Code 2600—Supplies

Date	Quantity	Description	Code	Invoiced	Req. req.	Purch. req.	Estimate amount	Control amount	Voucher or P.O.#		Correction	Control month
		December total to this point					$ 1,369.76	$ 1,321.24			—$ 48.52	
12/26	4	Thermimeters	2653	V	2076	30534	54.30	54.30	18567			April
12/27	6	Rings	2653		2097	31276	14.65					
12/27	5	Each of vacuum tubes #8642, 8643, 8644	2646	V	2122	31400	49.00	48.30	19211	+	.70	April
12/27	18	Rolls—16 mm super xx film	2642	V	2123	31416	72.00	78.34	19235	+	6.34	April
		December total					$ 1,559.71	$ 1,502.18			—$ 42.88	
		Total through December					$19,371.92	$19,187.51			—$169.76	
1949												
1/6	1	Heating element	2660		2462	33864	7.30					
1/15	25	Steel panels	2613		2928	35929	12.00					
		January total					$ 19.30					
		Total through January					$19,391.22					

EXHIBIT 4

expenditures during the month just closed (P) to disclose any necessary changes in spending policy or adjustment of budget.

Cost Ledger Detail

The statistical office keeps a cost ledger which is supplementary to the records kept by the university director of accounts. This record provides the information on actual costs incurred in pursuing engineering research and is required by the statistical office for preparing invoices promptly for submission to sponsors. The record is also required for the preparation of the monthly summary and reports outlined above.

The research cost ledger contains a cover sheet for each project in which is recorded pertinent information about the contract: the sponsor, the contract amount and revisions, a record of the amount and date of each invoice, and of the date of payment of each invoice. It further contains for each project a sheet for each type of expenditure such as salaries, overhead, travel, equipment, supplies, etc. In respect of this detail, two kinds of records are kept:

1. For salary expense, travel costs, etc., where a record of the exact amount of expense is known by the statistical office at the time of recording, a record sheet is used showing the expense in detail and the amount. A separate column is added to show the month of the control sheet on which the charge eventually appears. The control sheet month information is required when invoicing governmental sponsors, who desire this information on the invoice in order to be able to check the official university accounting record when auditing the costs of the research.
2. When materials, supplies, etc., are ordered, it is generally impossible to determine the exact amount of the charge at the time the commitment is made. For this reason, an estimated amount must be used when the commitment is recorded by the statistical office on a record such as shown in Exhibit 4. The "Code" column shows the expense classification number. A check in the "Invoice" column indicates that the sponsor has been billed for the item. The "Res. Req." column contains the college of engineering serial number on the purchase requisition, and the "Purch. Req." column contains the purchasing department's requisition number. The "Estimated Amount" column shows the estimated cost at the time of ordering.

   After the item has been entered, invoice submitted by the vendor, paid by the director of accounts, and printed on the official accounting control sheet, the exact amount is ascertained by the statistical office from the control sheet and recorded on the account record in the "Control Amount" column, together with the order number in the "Voucher or Purchase Order" column and the date of the control sheet in the "Control Month" column. The "Control Amount," which is the actual amount paid, will not generally be exactly the same as the estimated amount. The difference between the control amount and the estimated amount is entered in the "Correction" column. (If the estimated amount is greater than the control amount, a negative correction figure is entered). Thus, for any period for which all estimated items have appeared on the control sheets, the "Estimated Amount" total, plus the "Correction" total (taking sign into account), equals the "Control Amount" total.

For example, the illustration shows that on December 27, eighteen rolls of 16 mm. Super XX film were ordered at an estimated cost of $72.00 by research Purchase Requisition #2123. This item appeared on the April control sheet and the actual amount paid was $78.34, involving a correction of +$6.34. This item was included in the last invoice submitted to the sponsor and a check is therefore placed in the "Invoiced" column. On January 15, 1948, twenty-five steel panels were ordered at an estimated cost of $12.00 on Res. Purchase Requisition #35929. This item has not yet appeared on a control sheet and, of necessity, has not yet been invoiced. Similarly, the six rings ordered on December 27 have not yet appeared on a control sheet.

The illustrated record of supplies is a continuation of previous sheets and the first item listed is the total of December expenditures taken from the previous sheets. In this case, all items on the previous sheets have appeared on the control sheets. For the December total to date, the control amount of $1,321.24 therefore equals the estimated amount of $1,369.76 plus —$48.52. The December total control amount of $1,502.18 equals the total estimated amount $1,559.71 plus total correction of —$42.88 minus the estimated item which as yet has no control amount, $14.65. This same equation applies to the cumulative totals as well and is used as an accuracy check. The control amount and correction totals are placed in pencil until all previous control amounts have been ascertained.

Reconciliation of Controller's and Statistical Office Records

The item labeled commitments on the monthly project and summary reports is the sum of all the estimated costs and items which have not yet been received or for which the university has not been billed or has not yet paid, or items which have not yet appeared on the official accounting control sheets. It is the sum of the "Estimated Amount" columns plus the "Correction" columns minus the "Control Amount" column of each account. In preparing the monthly expenditure reports, the total of old commitments which have become recorded expenditures during the month is subtracted from the new commitments to get a net monthly additional commitment figure. If this subtraction were not made, the

items would be added to the total expenditures twice because these old commitments now appear in the materials and supplies monthly expenditure figure.

Thus, at any particular time, the charges on the official university tabulating accounting records (as recorded on the control sheets) will be less than those appearing on the statistical office records by the volume of requisition paperwork in process in the various departments of the comptroller (such as the purchasing department or the office of the bursar, which makes salary payments). The cost recording methods described above permit continous reconciliation of the official accounting charges with the statistical office control records. Moreover, since the statistical office prepares the accounts receivable invoices, this reconciliation record permits the indexing of each cost item on the invoices with the date of the official control sheets on which the charges have appeared. This procedure, of course, is required to facilitate cost audits by the sponsoring organization.

A System Which Has Proven Simple and Successful

The methods for controlling research costs described in this paper have proven very successful. They have been extremely advantageous in providing effective up-to-date cost control as required by the college administration and the directors of the various research projects. They have enabled the college to submit prompt, accurate invoices to sponsors, as well as to provide the sponsors with such periodic financial and cost reports as they require. Although it has provided all the necessary information for effective control of costs and for required historical analyses of research operations, the system has been kept simple. Because of its simplicity, it has accomplished this control at an almost insignificant clerical cost.

THE EMPLOYEE RATING SIDE OF WAGE ADMINISTRATION

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Who should rate employees? How frequently should ratings be undertaken? What elements should the raters consider? When should ratings be considered sufficiently reliable to serve as a basis for action? The present article supplies the author's answers to these and like questions, based on his own and his company's experience. The view is expressed that established ratings, when objective and free from caprice, are important control tools.

EVALUATION of individual ability and performance is a definite responsibility of management. This becomes especially clear whenever job evaluation and wage administration are attempted in any comprehensive way. After jobs have been rated and employees classified according to occupations or type of work performed, marked differences in rates of pay between workers doing the same job are invariably found. Management must undertake to determine whether or not these differences are warranted.

To find this out involves a number of other questions. How does one employee compare with another in terms of performance and value to the organization? How much more, or less, is one person worth than others doing the same work? Who are promotion prospects because of their interest, knowledge of their jobs, and outside efforts to improve themselves and qualify for advancement?

Employee Rating—What Is It and What Will It Do?

It is, of course, possible to pass judgment on employees on the basis of general impressions, opinions, or "hunches." Plainly, however, it is better to try to appraise individuals in terms of definite performance factors. For one thing, the area of employee rating is one of the most concrete places to promote sound industrial relations. Management should see to it that its decisions are based on facts rather than on guesses, on a consistent and well thought out policy rather than on expediency and opportunism, and on fairness and reasonableness rather than on prejudice and

arbitrary action. In short, a plan of employee rating must be made use of. Employee rating is the evaluation of individual ability and performance in terms of definite factors. Job rating should not be confused with employee rating. Job rating is a means of evaluating jobs without regard to the individuals performing those jobs, whereas employee rating evaluates the ability and performance of the employee performing the jobs. As with all other useful devices, it is well not to expect too much—or too little—of employee rating. Properly conducted, an employee rating plan:

1. Is invaluable in making wage adjustments, determining whether an employee deserves an increase, and preventing unwarranted inequalities in rates of pay.
2. Can be effectively used in appraising new employees at the end of their first, second, and third months, and for determining at the end of that time whether their performance warrants their being retained. The practice of reviewing the performance of new employees at the end of three months, for example, and deciding definitely whether the employee's performance warrants his being retained, is being increasingly adopted.
3. Provides a factual basis for decisions as to transfers, promotions, lay-offs, or dismissals.
4. Affords individual ratings which can be used to stimulate interest in self-improvement where the rating shows an unsatisfactory performance. Ratings should be used in such cases in a friendly and constructive way.

Choosing and Training the Raters

Employee rating is most effective when the immediate supervisors of the employees concerned participate. This means such persons as assistant foremen, foremen, supervisors, and others. In cases where an employee works for a supervisor, an assistant foreman, and a foreman, it is advisable to have all three rate the individual.

Ratings should not be averaged. Where more than one person rates an employee, all should review the several ratings after each has completed his own. Obviously there will be differences. If the raters understand the plan and know the employee well, there should not be a wide disparity. Rather than resorting to averaging, the differences should be taken up, discussed, and an agreement

reached as to which scoring most nearly reflects the individual's performance.

It is important that uniform instructions be given those who are to do the rating. Unless the same rules are applied by all who rate the various individuals in the company, the results will not be comparable and the persons rated will not be fairly treated. The importance of this is obvious in respect of all the normal purposes of rating, especially if the rating plan is to be used as a basis for promotions, transfers, lay-offs, etc. The over-all purpose of rating is to minimize prejudices which are so prevalent in snap judgment ratings. Every effort should be made to present clear instructions and to encourage deliberation in analyzing the value of every individual. The use of discussion groups similar to those used in the conference method of training foremen will prove beneficial.

When rating sheets are distributed to those who are to do the rating and no instructions (or very brief ones) are given, there is bound to be a greater difference in several ratings of the same individual than actual differences of opinion would account for. In order to obtain uniform interpretations, it is necessary that all the raters be thoroughly informed by someone who is familiar with all phases of the plan. In addition, the raters should be given an opportunity to ask questions regarding factors not understood.

The Rating Procedure

Up to this point certain over-all considerations have been accorded what is felt to be desirable emphasis. What about the central procedure of employee rating? When it is decided that an employee rating survey is to be made, the following procedure may well be followed:

1. Make one individual responsible for the application of the employee rating plan. In larger plants, the industrial relations manager should be responsible for its operation. In smaller plants the superintendent, himself, should be responsible for it.
2. Check with each supervisor to be sure that he understands the plan and factors thoroughly.
3. Furnish each supervisor with a set of rating sheets for his employees. Type or addressograph each employee's name and clock number on a rating sheet.
4. Tell the supervisor when the sheets are to be returned.

5. Have the supervisor rate every employee under his supervision. Each supervisor can be called into the office of the person in charge of application of the employee rating plan and given whatever assistance is necessary to do a complete job. By carefully discussing each employee and his qualifications with an unbiased person in terms of concrete facts, the supervisor can be very effective in making accurate ratings. The best results will be secured in the larger plant if the industrial relations manager sits down with each foreman and helps him think out the ratings. This does not mean the industrial relations manager should do the rating. *The ratings should always reflect the best judgment of the foreman* himself and this naturally applies to others who may perform ratings. The industrial relations manager should confine himself to asking questions and getting the foreman to express himself in terms of the factors involved in the rating process. In the small plant, the foreman should rate his men first and then go over the ratings with the superintendent and both should finally agree on each man's rating.

Completed ratings should be checked or reviewed by either the personnel department or an executive of higher rank than those doing the rating. It is generally agreed that each new rating should be compared with the previous ones. The principal value of reviews and comparisons is to reveal any great discrepancy in ratings and to determine whether or not employees are making progress. After the ratings are completed, checked, and reviewed, the total rating points for each employee are secured by adding up the point values representative of the degree of each factor checked for each employee. The total rating points for each employee indicates the relative rating of that employee as compared to others. In cases which seem definitely out of line the ratings should again be checked.

Most companies using an employee rating plan, rate their employees either once or twice a year. In the case of new employees, the rating form can be used to determine the qualifications of each for his job before he attains a permanent status on the payroll. For example, it is suggested that all new employees be rated at the end of thirty days and again at the end of ninety days to determine whether their progress on their particular jobs is satis-

factory and whether they are performing in a manner to justify retaining them on the payroll.

Basis of the Ratings

Factors or items on the rating form should supplement information already available and should cover a sufficient number of different aspects of an individual's performance to give a rounded "profile" of the worker. At the same time, the total number of items should not be so large that raters become careless in completing the form. My experience would indicate that not over twelve factors should be included on the merit form. If possible, the number should be less. The factors on the rating form should be pertinent to the actual work of the individuals being rated, and therefore, directly observable.

The following factors, in my opinion, should be considered on any worth-while rating form:

Quality of Work. Consider neatness and accuracy of work regardless of volume.

Quantity of Production. Consider the volume of work produced under normal conditions.

Dependability. Consider the manner in which the employee applies himself to his work, i.e., whether or not he does jobs on time, and the amount of supervision he requires.

Knowledge. Consider his understanding of all the requirements of his job or trade such as knowledge of methods, materials, etc., which have been gained through experience or general and special training.

Judgment. Consider the wisdom of his decisions in the absence of detailed instructions.

Personality. Consider the effect upon people of his appearance, way of acting, and disposition.

Initiative. Consider his ability to think along original lines, to find new ways of doing jobs, etc., and how often he makes suggestions for improvements.

Establishing the Employee Rating Program

Many installations of employee rating have failed because the plan has been applied hurriedly and the results used before being thoroughly checked. However, it is possible to do a good job of employee rating the first time it is attempted. The procedure sug-

gested below will help to disclose any minor discrepancies in a plan's operation and to assure its consistent application. The employee rating program should not be used as an emergency measure, but as a long-range, established program for periodically checking individual employee performance and ability.

After the first rating has been completed, the sheets should be studied but, unless the management is reasonably sure the ratings are correct, no action should be taken on the basis of these ratings. It is then suggested that in three months the ratings again be made and, upon the completion of this second rating, the rating for all employees in each of the two instances be compared, analyzed, and studied. In cases of great disparity between the original and the second ratings, the rater or raters should be called in and asked to explain the change. If this is done diplomatically, the rater will benefit in that the standard of performance for each of the factors he is required to consider will become clearer.

When the comparison of the first and second ratings is completed and the necessary corrections made, the ratings may then be considered to indicate reasonably well the qualifications of each individual in the plant and may be used as a basis for wage determination, promotions, transfers, lay-offs, and the correction of individual weaknesses. Ratings can thereafter be compiled either on a semiannual or annual basis to afford a basis for judging the progress of the employees. In some cases, ratings are used when rehiring former employees who have been laid off due to lack of work or other reasons not considered matters of merit.

Value of Employee Rating

The value to management of any rating plan is proportional to the interest and support it receives from the supervisory forces and the length of time over which it is successfully applied. A single rating may be subject to considerable error, but a series of ratings tends to establish a more and more accurate measure.

While employee rating is an excellent tool for the use of management in checking its personnel, no rating plan can be expected to provide a cure-all for all personnel adjustments. We all know that personnel adjustments involve consideration of many things in addition to specific measures which can be devised for a man's present effectiveness or his potentialities for advancement. Ratings simply represent significant factors to be taken into consideration. They are no substitute for judgment.